IN THE UNITED STATES DISTRICT COURT FOR THE DISTRICT OF MASSACHUSETTS

PETER J. MILLER, an individual, CLIFFORD HOYT, an individual, and CAMBRIDGE RESEARCH AND INSTRUMENTATION, INC., a Delaware corporation, Plaintiffs, v. PATRICK TREADO, an individual, and CHEMIMAGE CORP., a Delaware corporation, Defendants.	**Civil Action No. 05-10367-RWZ**

PLAINTIFF'S RESPONSE TO
DEFENDANT'S MOTION TO STAY COUNT 1 AND DISMISS COUNTS 2-5

Plaintiffs Cambridge Research and Instrumentation, Inc. ("CRI"), Peter J. Miller, and Clifford Hoyt oppose defendants ChemImage Corporation's ("ChemImage") and Patrick Treado's Motion to Stay Count 1 of Plaintiffs' Complaint pending completion of reissue proceedings now before U.S. Patent and Trademark Office ("PTO").

As required by LR 7.1(b)(2), plaintiffs hereby present, in the same document, a memorandum of reasons, including citation of supporting authorities, why the motion to stay should not be granted.

With respect to Defendants' Motion to Dismiss Counts 2-5, plaintiffs do not oppose dismissal of those counts without prejudice at this time.

STATEMENT OF FACTS

Plaintiff CRI, based in Woburn, Massachusetts, develops and sells precision equipment for the measurement and control of light, including liquid crystal tunable filters (LCTFs), microscopes, and spectrometers. Plaintiffs Peter J. Miller and Clifford Hoyt are employees of CRI and have been CRI employees at all relevant times.

Defendant ChemImage, based in Pittsburgh, Pennsylvania, is assignee of the patent-in-suit and sells, among other things, Raman imaging microscopy systems. Defendant Patrick Treado is the president of ChemImage, and has been an employee of ChemImage (or its predecessor ChemIcon, Inc.) during all relevant times.

In the mid 1990's, plaintiffs and defendants collaborated on several projects ("the CRI/ChemIcon collaboration") using, among other things, plaintiffs' liquid crystal tunable filter (LCTF) technology and plaintiffs' broad expertise in optics. In one project ("the SBIR proposal" – described in detail in the complaint, ¶¶7-9, 11-17; see Exhibits A-C to the complaint), plaintiffs and defendants collaborated on the development of a chemical imaging system having infinity-corrected optics and a Lyot-based LCTF for an imaging spectrometer. Before the collaboration, plaintiff Clifford Hoyt had conceived the idea of using "infinity space," or infinity-corrected optics, in an imaging microscope using an LCTF. Complaint, ¶10. During the collaboration, it was found that the Lyot-based LCTF did not perform well, and a new design based on an Evans split-element LCTF was conceived and reduced to practice by plaintiff Peter J. Miller. Exhibit B to the complaint, page 5.

Prior to October 13, 1999, plaintiff CRI built and sold to defendant ChemImage or its predecessor ChemIcon Evans split-element LCTFs optimized for use in Raman imaging microscopes using near infrared radiation. Exhibit C to the complaint, Appendix 2A

On October 13, 2000, defendant Patrick Treado, Matthew Nelson, Scott Keltzer, and Juliana Riber filed a provisional patent application entitled "Near Infrared Chemical Imaging Microscope" with the PTO. One year later, defendant Treado, Nelson, and Keltzer filed U.S. Patent Application Ser. No. 09/976,391 ("the '391 application") claiming priority from the provisional patent application. At no time were the plaintiffs informed of these applications.

The patent-in-suit, U.S. Pat. No. 6,734,962 ("the '962 patent"), issued from the '391 application (Exhibit F to the complaint). Claim 1 of the '962 patent recites a chemical imaging system using near infrared radiation (NIR) comprising, among other things, a light collector and an imaging spectrometer, Claim 3 recites that the light collector can be an "infinity-corrected … microscope objective," and Claim 4 recites that the imaging spectrometer can comprise an "Evans Split-Element" LCTF.

Upon learning of the '962 patent, plaintiff CRI promptly contacted defendant ChemImage to express CRI's concerns regarding inventorship in an effort to negotiate a settlement that would avoid litigation. On December 29, 2004, CRI sent a letter to ChemImage presenting CRI's views on the inventorship issue (Exhibit G to the complaint). Counsel for defendant ChemImage responded by letter dated January 20, 2005 (Exhibit H to the complaint):

> While the SBIR proposal suggests that Peter Miller and Dr. Treado collaborated on certain technology, much of the subject matter described in the SBIR proposal was invented by Dr. Treado before any such collaboration took place. The fact that Peter Miller and Dr. Treado may have collaborated on ideas previously invented by Dr. Treado does not in any way diminish Dr. Treado's position as the sole inventor of the technology that he (and ChemIcon) brought to the SBIR proposal.

Plaintiffs commenced this action on February 24, 2005. Count 1 of the complaint seeks an order under 35 U.S.C. §256 correcting inventorship of the '962 patent by naming plaintiffs Peter J. Miller and Clifford Hoyt as co-inventors of '962 patent. Counts 2-5 seek a declaration

that the '962 patent and its progeny are unenforceable for inequitable conduct and/or invalid in view of the prior art. After plaintiffs commenced this action, and unbeknownst to them, on March 30, 2005, defendants filed an application with the PTO to reissue the '962 patent-in-suit. In an oath which accompanied the reissue application, defendant Treado asserts that defendant Treado, Nelson, and Keltzer "are the original and first inventor(s) of the subject matter which is described and claimed in United States Patent No. 6,734,962 …" (Reissue Declaration, Exhibit A to defendant's motion to stay and dismiss, item (2) on page 1) — the very assertion that plaintiffs are contesting in Count 1 of this litigation. In fact, the reissue application makes no mention of the inventorship issue raised in Count 1 of plaintiffs' complaint.

Instead, the basis for the reissue is that an error had been made during the prosecution of the '962 patent. Specifically, defendant Treado declared in the reissue oath that "we may have claimed more than we were entitled to claim in claims 1, 12, and 13 of the '962 patent in view of" two prior art articles, both of which list defendant Treado as a co-author (Reissue Declaration, Exhibit A to defendant's motion to stay and dismiss, item (6)(e) on page 2).

In the reissue oath, defendant Treado further declared that "we failed to appreciate this error during the prosecution of the patent application" (*Id.*, item (6)(f) on page 2). In other words, defendant Treado alleges that he did not understand that the claims of the '962 patent covered subject matter disclosed in the references he co-authored.

Ostensibly to correct this error, the reissue application (1) canceled the term "scattered" from the claims, thereby presumably excluding Raman imaging which relies on scattered light; and (2) added to the claims that the spectrometer is an LCTF (*Id.*, item (6)(e) on page 2, item (6)(g) on page 3, and item (i) on pages 4-5).

On April 29, 2005, defendants filed a combined motion to stay Count 1, and to dismiss Counts 2-5, maintaining that Count 1 should be stayed because the defendants had filed an application with the PTO to reissue the '962 patent, and the PTO is the appropriate forum in which to resolve the inventorship issues raised by the plaintiffs, and that Counts 2-5 should be dismissed because no "justiciable case or controversy" has been alleged.

As stated above, plaintiffs do not oppose dismissal without prejudice of Counts 2-5. However, for the reasons explained below, plaintiffs oppose the stay of Count 1 pending the completion of the reissue proceedings before the PTO.

SUMMARY OF ARGUMENT

Plaintiffs oppose defendants' motion to stay Count 1 for at least the following reasons:

A. Legal authority weighs against granting a stay. First, defendants have raised the specter of a reissue proceeding that no longer exists in order to justify a stay. The three cases relied upon by defendants to support a stay were decided in the period 1977-1982, when reissue proceedings permitted extensive third party participation and considered issues such as deceptive intent. As discussed in the three cases relied upon by defendants, one purpose of the 1977-1982 reissue proceedings was to allow courts to stay litigation while the PTO simplified and/or resolved the issues. However, that type of reissue proceeding was eliminated in 1982, and reissue proceedings today permit essentially no third party participation and do not consider issues such as deceptive intent. For example, the reissue proceeding commenced by defendants will not consider whether defendant Treado's reissue oath that defendant Treado, Nelson, and Keltzer are "the original and first inventor(s) of the subject matter which is described and claimed in" the '962 patent was made with deceptive intent.

Second, the factors the court should consider in determining whether to grant a stay weigh against a stay of Count 1. A stay will unduly prejudice or tactically disadvantage the plaintiffs (the non-moving party), a stay will not simplify the issues in question and streamline the trial, and a stay will not reduce the burden of litigation on the parties and on the court.

B. Count 1 was brought under 35 U.S.C. §256, which establishes a cause of action for resolving inventorship disputes in federal court. By contrast, reissue proceedings of the PTO are intended for resolving invalidity issues concerning prior art. Although such proceedings may be used to **correct** the inventorship of a patent, they cannot be used to resolve and **determine** the inventorship of a patent. Thus, defendants' reissue proceeding is not the appropriate forum for resolving the parties' inventorship dispute. Rather, this Court is the appropriate forum for resolving Count 1.

C. Defendants' reissue proceeding cannot, and will not, resolve the inventorship issues raised by Count 1. First, the claims pending in the reissue application still recite subject matter which plaintiffs allege was invented by plaintiffs Hoyt and Miller—for example, the use of infinity-corrected optics and an Evans split-element LCTF. Second, defendants have not raised inventorship as an error or mistake being corrected in the reissue proceeding (if defendants were seeking correction of inventorship, they would have been required to so state in the reissue oath), and have stated only that the reissue amendments are for distinguishing over the prior art. Thus, the PTO will not even explore the inventorship issue.

ARGUMENT

A. CASE LAW WEIGHS AGAINST GRANTING A STAY

(1) THE AUTHORITIES CITED IN DEFENDANTS' MEMORANDUM OF LAW ARE OUTDATED

The cases cited by defendants to support their motion to stay Count 1 pending the outcome of the PTO's reissue proceeding are based on outdated law. Specifically, the three cases defendants cite to support a stay pending a PTO reissue proceeding,[1] Starlight Assoc. v. Berkey-Colortran, Inc., 201 U.S.P.Q. 307, 307 (S.D.N.Y. 1978); Johnson & Johnson, Inc. v. Wallace A, Erickson & Co., 627 F.2d 57, 60 (7th Cir. 1980); and Fisher Controls Co., Inc. v. Control Components, Inc., 443 F. Supp. 581 (S.D. Iowa 1977) (which provides the bulleted list of reasons for staying a litigation pending a reissue proceeding reproduced on page 8 of defendants' memorandum of law), are from the period 1977-1982, when the PTO attempted a new type of reissue proceeding.

Effective on March 1, 1977, the 1977-1982 reissue proceedings provided for the direct participation of third parties. 42 FED. REG. 5588, 5594-95 (Jan. 28, 1977). As stated by the Fisher Controls, Inc. court, "[a]lthough not equal to the litigation opportunities of discovery and confrontation, the new rules [for reissue proceedings] do allow for protest" where a third party could actively participate in the reissue proceeding, provide comments on both the actions of the

[1] In the defendants' argument for a stay of this litigation, they cite two additional cases cited besides the three listed here. The two cases, Gould v. Control Laser Corp., 705 F.2d 1340 (Fed. Cir. 1983) and GPAC, Inc. v. D.W.W. Enterprises, Inc., 144 F.R.D. 60 (D.N.J. 1992), are cited for the unremarkable truism that "[f]ederal courts have the inherent authority to order a stay pending conclusion of a proceeding in the PTO." Defendant's Memorandum of Law, page 8.

These two cases do not involve a stay of a litigation pending completion of a reissue proceeding, but rather a stay of litigation pending completion of an *ex parte* reexamination – an *ex parte* re-examination in which a third party (i.e., not the patentee) had filed the reexamination application. Both cases rely on the underlying legislative purpose of reexamination proceedings, not reissue proceedings, as the basis for determining the appropriateness of the stays. Gould, 705 F.2d at 1342 and GPAC, Inc., 144 F.R.D. at 62 et seq. Furthermore, in the Gould case, the Federal Circuit did not reach the merits of the stay, because the court found that the lower court's stay order was not final, and thus not reviewable. Gould, 705 F.2d at 1341.

PTO and the applicants' responses, and receive responses from both the applicant and the PTO. Fisher Controls Co., Inc., 443 F. Supp. at 581. The 1977-1982 reissue proceedings resembled an administrative hearing in which both the applicant and interested third parties could participate. See, *e.g.*, 47 FED. REG. 21746.

One purpose for the 1977-1982 reissue proceedings was to allow a court to stay its proceedings so that the PTO could issue an "advisory opinion." Johnson & Johnson, Inc., 627 F.2d at 60 (citing the same article from THE THIRD BRANCH cited in Fisher Controls Co., Inc. and in the defendants' memorandum of law) ("One purpose of the 1977 amendment was to permit a patentee whose patent was challenged by prior art or charges of fraud on the Patent and Trademark Office, to initiate a reissue application and, at the same time, to seek a stay of judicial proceedings wherein the challenges were brought, until the Patent Office granted or rejected the reissue application.").

On May 19, 1982, however, the PTO amended its rules to eliminate this type of reissue proceeding. 47 FED. REG. 21746. The PTO had discovered that "the patent examiners in the Office are not trained as hearing examiners and have no substantial experience in handling *inter partes* matters," i.e., they lacked the capabilities required by the new reissue proceedings, and many courts had ignored the PTO's advisory opinions. *Id.* Citing the excessive resources that had been required to deal with the "extensive participation by protestors during application examination," the PTO sharply curtailed the participation of third parties. *Id.* Today, third parties in reissue proceedings "will not receive any communications from the Office relating to the protest, other than a self-addressed postcard … ." 37. C.F.R. §1.291(c). Furthermore, "[i]n the absence of a request by the Office, an applicant has no duty to, and need not, reply to a protest." *Id.*

When the PTO amended its rules in 1982, it also sharply curtailed what the Examiner in a reissue proceeding may investigate. Unlike in 1977-1982, today an Examiner in a reissue proceeding today is explicitly directed to **not** investigate fraud or other inequitable conduct (such as deliberately not listing co-inventors) when raised by a third party protester. 37 C.F.R. §1.291(b) ("Protests raising fraud or other inequitable conduct issues will be entered in the application file, generally without comment on those issues."). The PTO leaves it to the courts to resolve such issues. MANUAL OF PATENT EXAMINING PROCEDURE (MPEP) §1448 ("Applicant's statement in the reissue oath or declaration of lack of deceptive intent will be accepted as dispositive except in special circumstances such as … [a] **judicial determination** of fraud, inequitable conduct, or violation of the duty of disclosure" (emphasis added)).

It is not surprising, therefore, that the reasons given in the three cases cited by the defendants for staying a litigation pending a reissue proceeding are no longer applicable. First, although a 1977-1982 reissue proceeding would consider issues of fraudulent inventorship, today's reissue proceeding relies upon the courts to resolve such issues. MPEP §1448, cited above. Second, although a 1977-1982 reissue proceeding allowed extensive third party participation, today the PTO will not even consider the issue of fraudulent inventorship.

(2) UNDER THE APPROPRIATE AUTHORITIES, THE FACTORS WEIGH AGAINST A STAY

The power to grant a stay in a pending litigation is an inherent part of a court's authority to control its calendar. Landis v. North American Co., 299 U.S. 248, 253-54 (1936). It is a discretionary power, however, and must be exercised in a manner that considers the competing interests of the litigants and the orderly administration of justice. CMAX v. Hall, 300 F.2d 265, 268 (9th Cir.1962). The central question is whether a stay pending the outcome of the reissue

application will be of significant benefit so as to justify a further delay. Tap Pharmaceutical products, Inc. v. Atrix, 70 U.S.P.Q.2d 1319, 1320 (N.D. Ill. 2004)

When ruling on such a stay, courts have considered the following factors: (1) whether a stay will unduly prejudice or tactically disadvantage the non-moving party, (2) whether a stay will simplify the issues in question and streamline the trial, and (3) whether a stay will reduce the burden of litigation on the parties and on the court. Wireless Spectrum Techs., Inc. v. Motorola Corp., 57 U.S.P.Q.2d (BNA) 1662, 1663 (N.D.Ill. 2001).

These factors will be considered in reverse order.

Because the claims in the reissue proceeding still recite subject matter which plaintiffs contend was invented by plaintiffs Hoyt and Miller, plaintiffs would still file a §256 correction of inventorship suit if a reissue patent was granted on defendants' amended claims. Thus, if a stay of Count 1 was granted, the burden of litigation would not be reduced at all. Yates-American Mach. Co., Inc., v. Newman Mach. Co., 694 F.Supp. 155 (M.D.N.C. 1988). Moreover, the inventorship issue has not even been raised in the reissue proceeding, and therefore will not be addressed. Thus, there is no added burden of allowing the litigation to proceed simultaneously with the reissue proceeding.

Plaintiffs filed the present complaint in order to correct inventorship under §256 on the basis that the defendants have omitted plaintiffs Hoyt and Miller as co-inventors in the '962 patent. In response, defendants filed a reissue application and then asked the Court to stay this litigation because of the pending reissue proceeding. However, the defendants have declared to the PTO that the purpose of the reissue proceeding is for amending the claims so they do not read over prior art. Thus, duplication of effort is not a concern.

Even allowing that defendants could narrow the claims during the reissue proceeding to the extent that plaintiffs were excluded from joint inventorship (which plaintiffs doubt is possible), Count 1 should still not be stayed pending that outcome because that would effectively extinguish plaintiffs' rights as co-inventors of the '962 patent. The is significant becauseif plaintiffs had been originally listed as co-inventors, the defendants could not have filed the reissue application without their consent. Clearly, plaintiffs must be permitted to protect their rights as co-inventors of the '962 patent, irrespective of plaintiffs' status as co-inventors of the claims issuing from the reissue application.

As stated by the Federal Circuit in another context, the "argument that the patents' claims were narrowed during prosecution, thereby curing any possible inventorship problems, misses the point." PerSeptive Biosystems, Inc. v. Pharmacia Biotech, Inc., 225 F.3d 1315, 1322 (Fed. Cir. 2000). Plaintiffs have come to this court seeking to be recognized as co-inventors of the '962 patent, a status denied them by defendants. Defendants should not be allowed to continue denying that status by moving the matter to an administrative agency which will not resolve the issue in dispute.

B. THE COURT IS THE APPROPRIATE FORUM FOR RESOLVING THE INVENTORSHIP ISSUES OF COUNT 1

Count 1 arises under 35 U.S.C. §251, which reads:

> **35 U.S.C. 256 Correction of named inventor.**
> Whenever through error a person is named in an issued patent as the inventor, or through error an inventor is not named in an issued patent and such error arose without any deceptive intention on his part, the Director may, on application of all the parties and assignees, with proof of the facts and such other requirements as may be imposed, issue a certificate correcting such error.
> The error of omitting inventors or naming persons who are not inventors shall not invalidate the patent in which such error occurred if it can be corrected as provided in this section. The court before which such matter is called in question

> may order correction of the patent on notice and hearing of all parties concerned and the Director shall issue a certificate accordingly.

35 U.S.C. §256 provides two methods for correcting inventorship of an issued patent: (1) petitioning the PTO for a Certificate of Correction naming the correct inventors; and (2) asking a court to order correction. MCV, Inc. v. King-Seeley Thermos Company, 870 F.2d 1568, 1570 (Fed. Cir. 1989) and MPEP §1402. The first method is appropriate when all the parties (including any unnamed co-inventors) agree about the inventorship error; the second method applies when the parties do not agree. See, e.g., MCV at 1570 (Fed. Cir. 1989) ("In the event consensus is not attained, however, the second paragraph of section 256 permits redress in federal court. *See* P.J. Federico, Commentary on the New Patent Act, 35 U.S.C.A. 1 (1954) ('If [the parties] do not concur, the correction can only be made on order of a court. . . . Section 256 . . . gives a court authority to order correction')") and Chou v. Univ. of Chi. & Arch Dev. Corp., 254 F.3d 1347, (Fed. Cir. 2001) (an unnamed co-inventor may sue the patentee under 35 U.S.C. §256).

Here, the plaintiffs and the defendants do not agree on the issue of inventorship (see Exhibits G and H in the Original Complaint), and, therefore, this Court is the appropriate forum for resolving this inventorship dispute.

C. THE REISSUE PROCEEDING IN THE PTO WILL NOT RESOLVE THE INVENTORSHIP ISSUES OF COUNT 1

(1) THE AMENDED PATENT CLAIMS IN THE REISSUE PROCEEDING CONTINUE TO RECITE SUBJECT MATTER CO-INVENTED BY PLAINTIFFS HOYT AND MILLER

The primary changes made to the claims of the '962 patent in defendants' reissue application are (1) deleting the term "scattered"; and (2) specifying that the spectrometer is an LCTF.

The deletion of "scattering" from the claims will have no effect on the contentions of the plaintiffs, i.e., the amended claims of the reissue proceeding still recite subject matter co-invented by plaintiffs. For example, Claim 3 still recites that the collecting/collimating device in Claim 1 may comprise a "refractive type infinity-corrected near infrared optimized microscope objective," which plaintiffs contend was invented by plaintiff Clifford Hoyt, and Claim 4 still recites an "Evans Split-Element liquid crystal tunable" filter, which plaintiffs contend was invented by plaintiff Peter J. Miller.

Amending the claims to recite that the spectrometer is an LCTF also will not resolve the inventorship issue and, if anything, brings the claims closer to plaintiffs' contribution in the CRI/ChemIcon collaboration -- namely, LCTF technology. As stated by defendant Treado during the CRI/ChemIcon collaboration, "CRI's liquid crystal tunable filter (LCTF) technology represents a revolutionary advancement in imaging spectrometer technology" (October 28, 1996 letter - Exhibit E to the complaint).

Plaintiffs had a long history of developing and selling light filtering technology (and specifically LCTF technology) separately from the CRI/ChemIcon collaboration. See, for example, "Multispectral imaging with a liquid crystal tunable filter", written by plaintiffs Hoyt and Miller and published in vol. 2345 of the Proceedings of the International Society for Optical Engineering (SPIE) in January 1995, which is attached to this Memorandum as Exhibit A. On page 357 of the article, plaintiffs Hoyt and Miller state that LCTFs can be used in the "near-IR range 700-1100 nm", while on page 358, it is noted that an LCTF can be placed within an optical system so that the image is "infinity-corrected".

Because the defendants' amendments to the claims in the reissue application still recite subject matter which plaintiffs contend was invented by plaintiffs Hoyt and/or Miller, the reissue proceeding will not resolve the inventorship issues raised by Count 1.

(2) DEFENDANTS HAVE NOT PRESENTED ANY OF THE INVENTORSHIP ISSUES RAISED IN COUNT 1 AS AN ERROR TO BE CORRECTED IN THE PTO REISSUE PROCEEDING

When a reissue application is used as a vehicle for correcting inventorship,[2] the PTO requires that the reissue oath state that "the applicant believes the original patent to be wholly or partly inoperative or invalid through error of a person being incorrectly named in an issued patent as an inventor, or through error of an inventor incorrectly not named in an issued patent as the inventor, and that such error arose without deceptive intention on the part of the applicant." MPEP §1412.04 and 37 C.F.R. §1.175.

Notably, the defendants have made no such statement in their reissue oath. Indeed, not only does the reissue application fail to mention any mistake regarding inventorship, the reissue oath actually re-asserts that the originally named inventors "are the original and first inventor(s) of the subject matter which is described and claimed in United States Patent No. 6,734,962 …" – the very assertion that plaintiffs are contesting in Count 1.

By not including, in their reissue oath, a statement that an error in naming inventors occurred in the '962 patent, the defendants have made clear that the reissue proceeding is not for the purpose of correcting inventorship.

(3) PTO WILL NOT, AND CAN NOT, REVIEW THE UNDERLYING FACTS CONCERNING THE INVENTORSHIP ISSUE RAISED IN COUNT 1

[2] Although the PTO prefers one file a request for a Certificate of Correction under the provisions of 35 U.S.C. §256 and 37 C.F.R. §1.324 when correcting inventorship in an issued patent (MPEP §1412.04), it has been held that 35 U.S.C. §251 (which authorizes reissue applications) may be used to correct misjoinder of inventors where §256 is inadequate. Ex Parte Scudder, 169 USPQ 814, 815 (Bd. App. 1971).

As stated above, regardless of the outcome of the reissue proceeding, the issue of the plaintiffs' co-inventorship of the '962 patent will remain unresolved. And if plaintiffs are co-inventors of the '962 patent, the defendants could not have filed the reissue application without plaintiffs' consent. So, regardless of the outcome of the reissue proceeding, this Court will still have to resolve the co-inventorship issue in the '962 patent. Indeed, if anything, the reissue proceeding should be stayed pending this Court's decision on Count 1.

Furthermore, a fundamental premise of a PTO reissue proceeding is that there is no deceptive intent on the part of the reissue applicant. 35 U.S.C. §251. Because of this, the reissue Examiner is instructed to accept certain assertions of the applicant at face value, without further analysis. As stated in MPEP §1448, "Applicant's statement in the reissue oath or declaration of lack of deceptive intent will be accepted as dispositive except in special circumstances such as an admission or judicial determination of fraud, inequitable conduct, or violation of the duty of disclosure". In other words, absent an admission by defendants that they lied when they declared that the named inventors on the '962 patent were the "original and first inventor(s)," it is only this court, through a judicial determination, that can decide this issue.

Defendants have filed an oath with the PTO stating that the originally named inventors are the "original and true" inventors of the subject matter in the '962 patent. Plaintiffs dispute this, and believe that the defendants had "deceptive intent" when they made that oath. However, plaintiffs cannot raise that issue with the PTO. 37 C.F.R. §1.291(b) ("Protests raising fraud or other inequitable conduct issues will be entered in the application file, generally without comment on those issues"). See also, Earth Resources Corp. v. United States, 44 Fed. Cl. 274, 278 (1999).

Because the reissue Examiner will not investigate allegations of deceptive intent concerning inventorship, and the plaintiffs have asserted that defendants, with deceptive intent, have denied plaintiffs Hoyt and Miller co-inventor status, the reissue proceeding will not resolve the inventorship issues raised by Count 1 and defendant's motion to stay Count 1 should be denied.

CONCLUSION

Defendants' strategy is clear. To the court, the defendants imply that the purpose of the reissue proceeding is to correct inventorship. To the PTO, the defendants assert that the purpose of the reissue proceeding is to avoid prior art. Next, defendants ask the court to stay the present litigation by implying that the reissue proceeding will resolve the inventorship issues. By this double-dealing combination, the defendants seek to effectively extinguish the plaintiffs' rights as co-inventors — to win this lawsuit without the plaintiffs ever having their day in court.

However, even if the PTO permits defendants to amend the claims in the '962 patent as indicated in the reissue declaration, the amended claims in and of themselves will not resolve the inventorship issues of Count 1. Furthermore, the PTO will not investigate the inventorship issues raised in Count 1. Because the reissue proceedings cannot resolve the inventorship issues raised in Count 1, the reissue proceedings should not be used as a substutute for proceedings before this Court.

For the reasons set forth herein, plaintiffs respectfully request that this court deny defendants motion to stay Count 1 pending completion of the reissue proceeding now before the PTO.

Respectfully submitted,

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Multispectral imaging with a liquid crystal tunable filter

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ABSTRACT

We report on a new class of instrument for imaging spectral analysis, the tunable liquid crystal filter (LCTF). The LCTF is an optical filter, similar to an interference filter, whose center wavelength is electronically tunable with no moving parts, in a few milliseconds, across hundreds of nanometers. The filter is a polarization interference filter based on the Lyot design, using the electro-optic action of liquid crystals to tune the passband. Imaging quality is near the diffraction limit and there is no image shift as the filter is tuned. Bandwidths ranging from a 0.25 nm to 60 nm have been achieved, for use in high-resolution sequential RGB imaging, microscopy of multiply-tagged fluorescent samples, bathymetry, and remote sensing. LCTFs are presently being applied to agricultural quality control measurements.

1. BACKGROUND

The past decade has seen the LCTF developed from a laboratory concept to a practical instrument. During this time, there has been an increasing use of liquid crystal optics in spectral analysis systems, including broadband tunable filters[1], notch filters for rejecting fluorescence excitation light[2], and wavelength selectors for multi-line laser systems[3]. Related work has led to construction of Lyot filters incorporating nematic liquid crystals to achieve narrow, continuously tunable bandpass[4-13]. A similar filter has been demonstrated[14] using ferroelectric C* and A liquid crystals. These filters provide the research community with a powerful tool for imaging spectroscopy, one having different strengths and weaknesses from more-familiar instruments such as grating spectrometers or filter-wheel cameras. This paper seeks to present these filters to the experimentalist, with attention to the theory of operation, their integration with other optical elements, and the presently achievable performance levels.

1.1. Lyot filters

The polarization interference filter was first described by Bernard Lyot in 1933[15], and the principle is illustrated in Figure 1. Linearly polarized light impinges on a birefringent crytal at a 45° angle, delivering components of equal intensity into its ordinary and extra-ordinary eigenmodes. Since the propagation speeds for the eigenmodes are different, the two components emerge with a relative phase delay, and when they recombine the polarization state is altered. The light is analyzed using a second linear polarizer, at which the transmission ranges from 0 to 1 depending on the wavelength, according to

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Malus' law:

$$T(\lambda) = \cos^2 (\pi d \cdot \delta n/\lambda) \quad (1)$$

The wavelength separation between transmission peaks of adjacent order (argument equal to $m\pi$ and $[m+1]\pi$, above), depends on the product $d \cdot \delta n$. This describes the relative phase retardation between the two eigenmodes passing through the crystal, and $d \cdot \delta n$ is said to be its retardance, R. A birefringent crystal, used this way, is termed a retarder or waveplate. For a waveplate with high retardance, adjacent transmission peaks are closely spaced, while a low-retardance element has a wider separation between peaks. The combination of a retarder and a linear polarizer, suitably oriented, makes up a single Lyot stage. A Lyot filter consists of several stages placed optically in series, with retarders selected to have a perfect binary sequence of retardance. Such a filter is diagrammed in Figure 2, and its transmission is plotted in Figure 3. Because of the binary retardance sequence, the transmission minima of any given stage blocks alternate transmission peaks of the previous stage. Overall, the assembly has a spectral width (FWHM) which is determined by the thickest retarder element, while unwanted adjacent orders are blocked by subsequent stages, yielding a free spectral range (FSR) which is set by the thinnest retarder element.

Lyot filters have been highly developed for solar astronomy [16,17], where filters with 0.025 nm bandwidths have been constructed. Theoretical analysis of these filters is performed using the Jones calculus to determine the overall transmission function, and together with the equation for the index ellipse, it permits one to determine the behavior for off-axis as well as on-axis rays. Variations on the Lyot design have been developed which provide improved field of view, or reduced polarizer count, along with filters exploiting only the spectral dispersion of retardance, and those which can be tuned by mechanical rotation of polarizing elements. Billings[18], Title[19], and others recognized that the complex tuning mechanisms used in these filters could be replaced by variable waveplates, if suitable devices were available, to produce a tunable imaging filter. Advances in this realm have enabled construction of the modern LCTF.

1.2. Liquid crystal waveplates

A cross-sectional view of a liquid crystal waveplate is shown in Figure 4. A thin layer of liquid crystal material (5 - 25 μ) is contained between glass windows coated with a transparent electrode made of indium-tin oxide (ITO). The properties of liquid crystal materials[20] and devices[21] have been extensively reported elsewhere, and are only summarized here. Liquid crystals constitute a partially ordered state of matter, exhibiting some of the properties of a liquid (low viscosity, individual molecules are free to move) and some of a crystalline solid (domains, macroscopic anisotropy of electrical and optical properties). The liquid crystals used in most LCTF's are nematic type, consisting of rod-shaped molecules with random positions, but with an orientational order so their long axes all point in roughly the same direction. While the orientation is imperfect ($S \approx .65$ is typical), the material behaves as a uniaxial crystal with its c-axis aligned with the rod direction, with different properties along the axis and perpendicular to it.

The molecules in a liquid crystal cell can be given a desired orientation by

coating the inner cell surfaces with a soft plastic and buffing it lightly. This causes the rod-shaped molecules to lie nearly parallel to the surface, oriented along the direction of buffing. Light passing in the direction z which is polarized along the buffing direction experiences the extra-ordinary index of the crystal n_e, while light polarized perpendicular to the buffing axis experiences the ordinary index n_o. In short, the liquid crystal cell is a waveplate like those described in Section 1.1, above.

Unlike a solid crystal, however, the liquid crystal material can be re-oriented by applying an electric field E in the direction indicated. The liquid crystal molecules, having a positive dipole moment along the rod axis, experience a torque in the presence of this field and re-align themselves partially with it, balanced by an intermolecular spring force from tightly-bound molecules at the two glass plate surfaces. Molecules in the center of the cell undergo the most re-alignment, while those at the edges are only slightly affected. The result of such a field is pictured in the right-hand half of Figure 4. The retardance of the liquid crystal waveplate is reduced by an amount which depends on the strength of the field E; the retardance can be smoothly varied from its maximum value (no E field) to nearly zero in a high field (the residual is due to molecules at the plate surfaces).

Devices like these have been studied for over twenty years[22-24], and are of great commercial importance to the display industry. Their exploitation in precision optical systems is the result of great improvements in the chemical and electrical stability of the materials involved, as well as the development of suitable construction techniques for small-volume fabrication of high quality optical devices. Problems associated with early liquid crystal displays, such as limited lifetime[25], poor contrast, domain defects[26], and sensitivity to UV and water exposure[27], are essentially eliminated nowadays. Waveplates of this type have been used in laser isolators[28] for inertial confinement plasma fusion reactors, in commercial laser intensity-control equipment[29], for solar magnetometry[30], polarization microscopy[31], and other demanding uses.

The response speed, peak transmission, and other properties of liquid crystal waveplates are discussed at length in the literature. Optical scatter is important at visible wavelengths, and dominates absorption as a loss term[32], while infrared resonance absorption rules out their use in some spectral bands [33]. Their depolarization properties have been measured in the visible using Mueller matrix methods[34], while optical dispersion has been studied[35] from 200 nm to 12 μ. Tuning of waveplates to a desired retardance can now be achieved using active servo-lock techniques[36], or by capacitive sensing[37], for improved linearity and thermal stability.

1.3. Tuning mechanism

A single stage of a LCTF is pictured in Figure 5. It differs from the Lyot stage pictured earlier in that a liquid crystal waveplate is placed in series with the (solid) crystal waveplate. Their optical axes are parallel, so the retardances add algebraically. We term the combination a hybrid retarder, since it possesses the tunability of a liquid crystal retarder atop the base retardance of a crystal retarder. The spectral response of the stage may be

calculated using Eq. 1 where the retardance of the two elements is summed, shifting the earlier curve by an amount which depends on the liquid crystal retardance. A retardance of λ_0 will shift the peaks by one order, while lesser retardances exert a smaller shift. In this way, it is possible to tune a stage so that any selected wavelength will experience a transmission peak, without ever requiring a retardance in excess of λ_0 from the liquid crystal waveplate. A Lyot filter constructed of several such stages can tune to pass any wavelength in its range, by tuning each element suitably. This is illustrated in Figure 6.

2. SPECTRAL COVERAGE

A wide variety of retarder materials exist with low loss and moderate birefringence over the range 400 nm - 5 μ. Quartz, MgF_2, CaF_2, $LiNbO_3$, calcite, KDP and its isomorphs, Mylar, PVA, and other materials have been employed successfully in Lyot filters and LCTF's.

If suitable blocking elements are provided, such as colored glass or interference filters, a filter may be operated anywhere within its optically transmissive range. Sometimes a narrowband LCTF filter is built with only a small FSR, and is used in concert with a removable pre-filter; this preserves versatility for use at different wavelengths in future research, without requiring construction of a large number of stages.

Generally, it is the properties of the polarizer material which restrict the spectral range. The properties of common polarizers is listed in Table 1. Because an LCTF uses many polarizers, and must have moderate aperture with minimum thickness, calcite polarizers are not generally an option. An array of small thin-film polarizer cubes has been used, but without improvement over high-performance sheet materials. Note that there are few polarizers available in the range $\lambda > 2\ \mu$, except wire-grid polarizers which operate by selective reflection, not selective absorption. While some materials exist for $\lambda < 400$ nm, this range is problematic for the liquid crystal waveplates, due to scatter, low transmission, and limited photo-stability of the liquid crystal materials.

Commonly, LCTF's are constructed for the visible range of 400 - 720, using polarizer material such as Sanritsu LL9218; or 450 - 750 using polarizer such as Polaroid HN38; or the near-IR range 700 - 1100 nm accessible to Si CCD detectors; or the range 1000 - 1700 nm, using infrared polarizer such as HR. The coatings, liquid crystal materials, and waveplate retardances are chosen accordingly for each range as well.

3. IMAGING QUALITY

A principal strength of the LCTF technique is that there is essentially no image shift as the filter is tuned. This is in contrast to devices such as AOTF's, where a dispersive relation yields image shift and smearing of out-of-band leakage[38]; filter wheels, where each filter introduces a different wedge into the optical path; and line-imaged gratings, where the spectral resolution requires the presence of such a shift. As a result, LCTF's are being used in applications where precise image registration is required between different spectral bands, such as airborne remote multi-spectral

imaging.

The residual image shift is set by wedge in the filter, and the dispersion in the materials used. To the extent that these are present, the LCTF behaves like a very weak prism. For practical devices, the wedge angle ϕ will be 5' of arc or less. An LCTF with 20 mm aperture and the optical dispersion of quartz, will produce an image shift of +/- 2" of arc (11 microradians) over the range 430 - 770 nm. This shift is 70 percent as large as the diffraction-limited spot size, and in many applications is acceptable. Tighter control of the wedge angle ϕ yields directly improved image shift in tuning, when this is necessary.

Other image degradation mechanisms include wavefront distortion in the LCTF, and scatter in the liquid crystal material. The former is set by the quality of the entrance and exit windows, for most practical devices. This is because the individual elements in the filter are generally figured to better than one or two fringes, and are then immersed in an index-matching medium (see Section 10, below). This reduces the wavefront errors of each interface by the factor $\alpha = (n_{element} - n_{medium})/n_{element}$, which achieves a value of 0.01 or less. Thus, internal interfaces contribute very little to the overall wavefront figure.

4. INCORPORATION INTO OPTICAL SYSTEMS

From a system optical design point of view, the LCTF is a thick planar optic like a window, and similar design techniques are used to minimize its effect on image quality. There are additional constraints placed by the LCTF because of its limited acceptance angle, and often (for reasons of expense) a limited aperture of 20 mm. Ideally, an LCTF is placed in a telecentric beam, as shown in Figure 7. Such a beam is obtained by locating a pupil stop at the focal point of the lens forming the beam which passes through the filter. This arrangement is widely used in solar astronomy for imaging of features in the H_α and Ca K atomic absorption lines, with fixed Lyot filters. It is recommended when peak optical performance is required, and the need for relay optics (which may have to be custom designed) and a relocation of the focal plane are acceptable.

A second approach is to place the LCTF in a pupil plane. Access to such a beam is commonly provided in 'infinity-corrected' microscopes. In such a beam, there is a one-to-one correspondence between ray angle and position in the image. Rays corresponding to each point in the image pass through the whole filter aperture, so center wavelength variations across the aperture have the effect of broadening the passband rather than shifting the center wavelength spatially across the image. This benefit may be outweighed by the mapping of systematic off-axis filter response into a systematic variation in center wavelength across the image. For optical systems with a small angular field (14° or less), the variation is usually small enough to be unimportant.

In some systems, it is acceptable to place the filter in front of the entrance lens. This is favored when the entrance lens aperture and field-of-view are consistent with the filter specifications, and the working distance d ≫ f, the lens focal length. This situation is similar to the pupil plane case just discussed, in that rays passing through the filter are nearly collimated. It has the advantages that mechanical integration is easy and the filter may be

easily used with a number of different lenses.

A less favored approach is to situate the filter near an image plane. This has the benefit that filter aperture can be minimized, but it places stringent scratch and blemish requirements on the filter in order to avoid image degradation.

5. PACKAGING AND ENVIRONMENTAL REQUIREMENTS

There are a number of packaging and environmental requirements on a practical optical device such as an LCTF, including overall size, available aperture, thermal range for operation and storage, lifetime, and ruggedness against environmental stresses such as static electricity, vibration, shock, UV light, and moisture. Present LCTF designs include a number of methods to meet these requirements.

Aside from efficient use of light and spectral uniformity across the field of view, one must consider spherical aberration and the other defects introduced by a thick planar optic such as an LCTF. To minimize these effects and avoid vignetting, the filter thickness must be kept to an absolute minimum. Each stage of the filter includes a polarizer, a fixed retarder, and a liquid crystal tuning element. The polarizer is generally mounted in glass rather than the usual cellulose acetyl butylrate (CAB) film, for improved optical performance. It has a thickness of ~ 0.5 mm. While off-the-shelf liquid crystal retarders have a thickness of 19 mm or more, much thinner components are required. These can be made with 2 mm thickness or less, using designs optimized for LCTF use. As a result, each stage is typically 2.5 mm thick, plus the thickness of the fixed retarder.

Liquid crystal retarders can be easily constructed with apertures up to 35 mm. Some liquid crystal manufacturers disperse small segments (~ 50 μ long) of optical fiber throughout the liquid crystal material to act as spacers and ensure uniform thickness of the liquid crystal layer across the aperture. This technique is almost universal in the manufacture of flat-panel displays, and enables construction of liquid crystal retarders with very large aperture (20 cm. or more). It has drawbacks, in that the fiber segments are scattering sites and there is no tuning in vicinity of the fiber. But the affected area can be a small fraction of the aperture (1/2% or less), so filters using these elements need not have substantial degradation of their spectral response relative to fiber-free devices. A filter of this type needs to be located in a pupil plane or a telecentric beam, to minimize image degradation.

Because a typical LCTF has 8-10 stages, it consists of 25 or more optical elements which must be held in tight mechanical registration. Most LCTFs use optical epoxy to bond elements together, creating a smaller number of sub-assemblies that are then mounted to a mechanical housing. This greatly simplifies the mechanical design and eliminates reflection losses at the bonded interfaces. However, it does reduce the LCTF's temperature range, due to epoxy material limits and thermal stresses. A range of 0 - 45 C is possible with present designs and materials.

While material properties and thermal stresses limit the storage temperature range, the operating temperature range is set by thermal drift in the liquid

crystal material. When the liquid crystal material is heated, the molecules become more energetic and the crystal order S() decreases. This, in turn, changes the dielectric and optical anisotropies which produce the electro-optic response, so the tuning curve shifts with temperature. The shifts are steepest when operating near the clearing point T_c, the temperature at which the liquid crystal undergoes a phase change to become an isotropic (normal) fluid. Design techniques to minimize thermal drift include use of materials with a high clearing point T_c, and placing a thermal sensor in the LCTF optics to allow compensating electrical drive with temperature.

6. CONCLUSION

The LCTF is an exciting new technology which enables multi-spectral imaging and imaging spectroscopy measurements to be made with unprecedented simplicity. By coupling the LCTF with a silicon CCD or other detector, a high-resolution imaging system with random-access spectral coverage is obtained. Modern LCTFs exhibit near-diffraction limited performance and there is no image shift in tuning. Optical registration of different spectral bands is excellent as a result.

7. ACKNOWLEDGEMENTS

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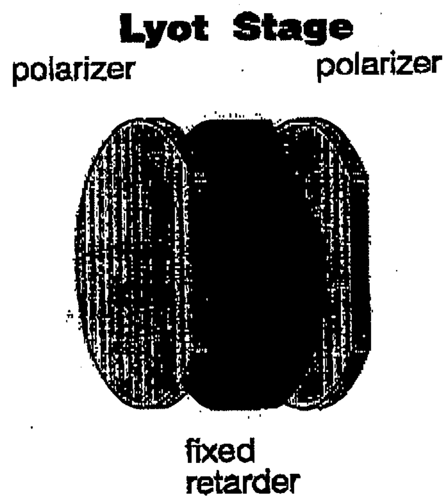

Figure 1. Lyot stage diagram.
Light passes from left to right through an entrance polarizer and is linearly polarized. Differential path length between ordinary and extra-ordinary eigenstates in the crystal retarder produces a wavelength-dependent polarization state, which is analyzed at a second linear polarizer to yield a spectrally periodic transmission.

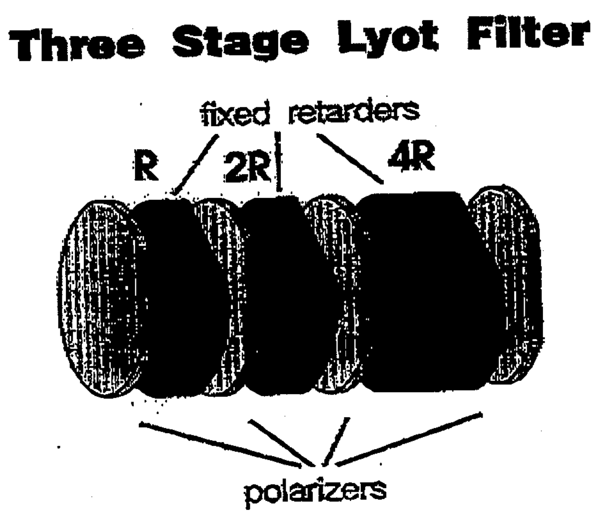

Figure 2. Lyot filter diagram.
A three-stage Lyot filter is pictured. Note that the retarders have a binary ratio of retardances.

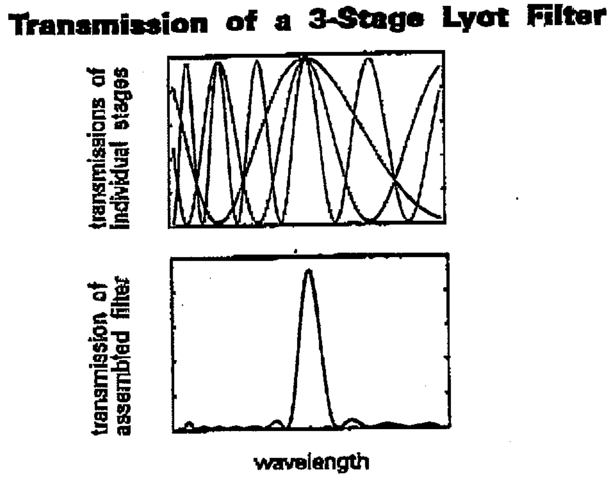

Figure 3. Lyot filter transmission.
The transmission of the three Lyot stages is pictured, along with that of the overall filter. It shows how a high overall filter extinction is achieved by use of many stages, and does not rely upon high extinction in any one stage.

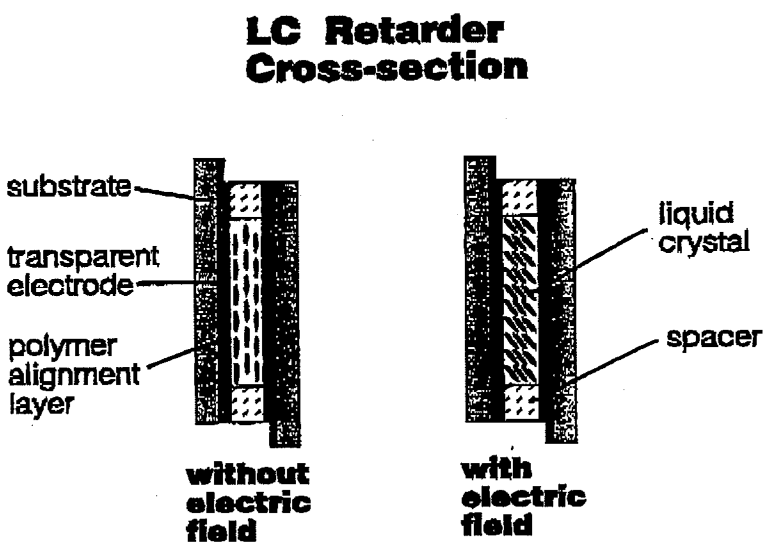

Figure 4. Liquid crystal retarder.
This is a cross-sectional view of a liquid crystal variable retarder. Light passes from left to right, through a thin layer (10 μ) of liquid crystal material which is oriented to lie nearly in the plane of the substrates. The drawing is not to scale, with the thickness of electrodes and polymers quite exaggerated. When an electric field is applied, the molecules experience a torque P x E between the field and the induced polarization dipole. This re-orients the molecules and the optical retardance is reduced.

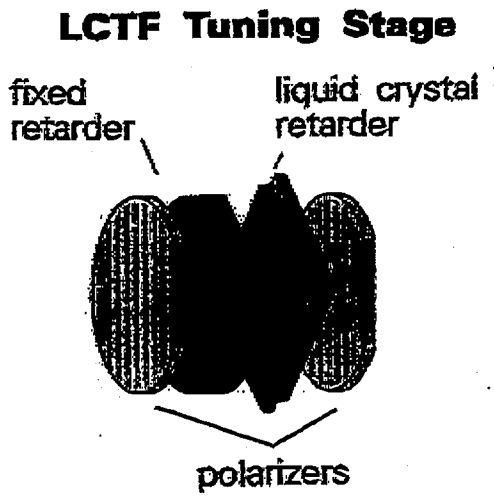

Figure 5. LCTF stage.
This illustrates how a liquid crystal retarder is placed in series with a quartz retarder to make a tunable Lyot stage. It behaves just like the Lyot stage shown earlier, but the pass wavelength is electrically adjustable.

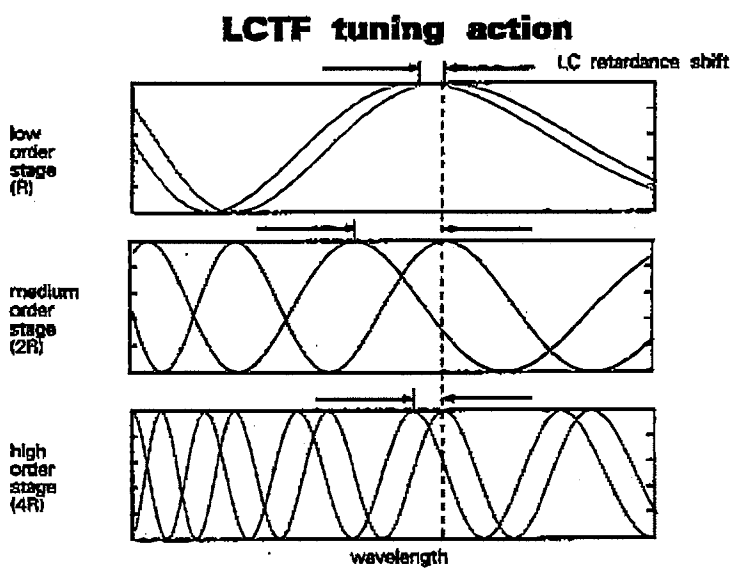

Figure 6. LCTF tuning diagram.
When several LCTF stages are placed in series, each one must be tuned by an appropriate amount to shift the overall filter peak to the desired wavelength. This is illustrated above, where the shift in each stage is shown, for a three-stage LCTF.

Table 1. Properties of common polarizer materials.

Polarizer Type	Transmission ($T_{\parallel}$)	Leakage $T_{\perp}$	Spectral Range	Aperture	Thickness
Visible dichroic (HN-38S)	84%	.005%	400-730 nm	>10"	0.030"
UV dichroic (105UV)	20%	1%	300-700 nm	4"	0.062"
IR dichroic (HR)	60%	0.5%	700-2000 nm	2"	0.030"
Rochon prism (RA10-10)	98%	0.001%	350-2000 nm	0.4"	0.5"
Wire grid (IGP227)	90%	2%	1500-5000 nm	1"	.062"